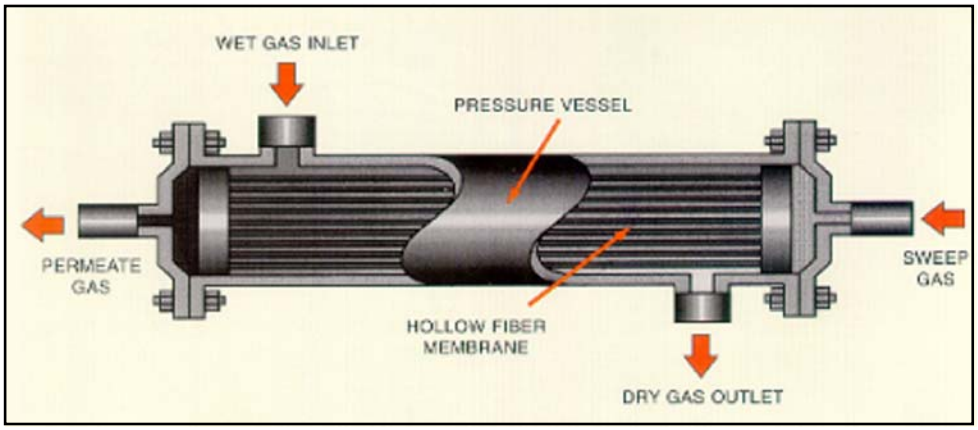
Industrial Technologies Program

Advanced Membranes Technology Platform for Hydrocarbon Separations

New Membrane Technology Promises More Efficient Separations

Currently, conventional chemical-based separations processes account for 40 to 70 percent of the capital and operation costs in the chemicals industry. They also result in emissions such as NOx, SOx, VOCs, methane, and hydrocarbons, and liquid wastes such as glycols. Membrane technologies are commercially available for hydrocarbon processing operations such as removal of CO2/H2S from natural gas and dehydration of natural gas. However, these technologies are hampered by such limitations as performance degradation, high energy consumption, hydrocarbon losses, equipment complexity, and high initial-purchase costs.

A new membrane technology promises lower operating costs, improved reliability, lower maintenance needs, and reduced environmental impact for hydrocarbon separations. This technology offers broad-based economic and environmental benefits to the natural gas industry, specifically through improved natural gas upgrading at offshore and remote onshore sites, improved operations at pipeline stations, elimination of liquid wastes and greatly reduced hydrocarbon emissions, and exploitation of natural gas hydrates. As natural gas is a major feedstock in the production of such high-volume chemicals as methanol, ammonia, and ethylene, the chemicals industry could realize substantial benefits. Other applications for the technology would include pervaporative dehydration, VOC recovery, and hydrocarbon separations-all important processes in the chemicals industry.



Membrane Dryer Schematic: *Natural gas at high pressure is dried by selective permeation of water vapor through the membrane. Dry sweep gas at low pressure carries away the permeated water vapor.*

Benefits

By 2020:

- *Energy savings of up to 100 trillion Btu per year in the natural gas industry*
- *Additional savings of up to 30 trillion Btu per year in other areas such as dehydration of organic liquids and VOC recovery*
- *Substantial reductions in emission of carbon, NOx, SOx, CO, VOCs; liquid wastes including glycols; and air pollutants such as methane and hydrocarbons*
- *Significant annual savings in operating costs through replacement of glycol with membrane technology*

Applications

The technology could benefit a wide area of the chemical industry, including natural gas, petrochemicals, industrial organic chemicals, and plastics. Besides natural gas upgrading, applications could include CO2 dehydration, pervaporative dehydration, VOC recovery, and hydrocarbon separations.

Project Partners

- *Air Products and Chemicals, Inc. Allentown, PA*
- *Petreco International Inc., Houston, TX*

Project Description

Goal: To develop a new membrane technology for superior, robust, low-cost membrane separator systems. These systems will crosscut multiple applications within the chemical and petrochemical industries that involve hydrocarbon separations, particularly: a) dehydration of natural gas, b) CO2 and H2S removal from natural gas, c) dehydration of CO2 gas, d) pervaporative dehydration of organic liquid mixtures, e) recovery of VOCs from vent streams, and f) separation of hydrocarbon gases.

The project team will develop new membrane systems that will enable stand-alone separation processes or synergistic combinations with other separation processes to realize substantial cost reductions. The membranes will incorporate high selectivity to enable significant reductions in energy consumption and environmental emissions compared to conventional processes.

Activities:

Phase 1 - Development of hollow-fiber membrane and module: Development and optimization of a hollow-fiber membrane and commercial-sized module for natural gas separations.

Phase 2 - Demonstration of membrane system for natural gas: Scaling up of the membrane to the manufacturing scale for limited production, design and fabrication of a demonstration system, and testing of the membrane system with an actual natural gas stream to demonstrate commercial viability.

Phase 3 - Demonstration of membrane for other high-tonnage applications: Identification of suitable applications and demonstration of commercial viability of the membrane through tests with actual process streams and technical/commercial evaluations.

Progress and Milestones

Near Term (years 1 to 2):

- User needs-and-wants study for natural gas separations
- Hollow-fiber membrane development
- Membrane module development

Mid Term (years 3 to 5):

- Fiber and module manufacturing process scale-up
- Design/fabrication of commercial membrane system
- Testing of membrane system with natural-gas stream
- Evaluation of energy/emissions/economic benefits

Mid Term (years 3 to 5):

- User needs-and-wants study for other high-tonnage applications
- Testing of natural-gas fiber for selected high-tonnage applications
- Evaluation of energy/emissions/economic benefits for selected applications

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U.S. Department of Energy
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March 2004